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AFGHANISTAN

ENGINEERING SUPPORT PROGRAM

WO-A-0080

Gas Pipeline Pre-Feasibility Study



January 23, 2012

This publication was produced for review by the United States Agency for International Development. It was prepared by Tetra Tech, Inc.

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January 23, 2012

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Enclosed is the report for WO-A-0080 Gas Pipeline Pre-Feasibility Study.

I look forward to meeting with you to discuss this report.

Respectfully,

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AFGHANISTAN ENGINEERING SUPPORT PROGRAM

WO-A-0080
GAS PIPELINE PRE-FEASIBILITY STUDY

January 23, 2012

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1.0 Overview

USAID has requested that Tetra Tech (Tt) conduct a pre-feasibility study of the construction of a 12 inch pipeline from the Dauletabad gas field in Turkmenistan to Herat. Construction of this pipeline would allow for the development of energy related businesses, such as a Thermal Power Plant producing up to 200 megawatts of electricity. The development of industry in the city of Herat is a priority to the governor of the province, USAID, and the Provincial Reconstruction Team.

While investigating the feasibility of construction of this line, there is a wealth of information available on the approved construction of the Turkmenistan, Afghanistan, Pakistan, and India pipeline (TAPI). The TAPI is a proposed natural gas pipeline being developed by the Asian Development Bank. The TAPI pipeline will transport Caspian Sea natural gas from Turkmenistan through Afghanistan into Pakistan and then to India. Any construction of a smaller pipeline, which would be replaced by the larger TAPI pipeline, would have to have an extremely favorable rate of return to justify the capital costs of construction.

Conclusion:

The cost of construction of a 12-inch gas pipeline and the associated development costs to construct a 200 Megawatt thermal power electric generating station cannot be justified compared to the relatively less expensive cost to purchase electricity from Turkmenistan and deliver it to the Herat area by high voltage transmission lines. Considering that construction of a 56 inch diameter natural gas pipeline is eminent, and has a signed international agreement between all parties, on the export and transmission of Turkmenistan's natural gas through Afghanistan, it would be difficult to negotiate a new agreement between Turkmenistan and Afghanistan to export a small quantity of natural gas. The TAPI pipeline has large infrastructure projects associated with it, resulting in large economies of scale and it would be difficult to construct a 12 inch pipeline within the same timeframe as the TAPI line is scheduled. The signing of a bi-lateral agreement, funding agreements, design and construction would require 5-10 years. In terms of both capital and time, the preferred option should be for the rapid construction of the TAPI pipeline for the development of industry in Herat province.

2.0 Discussion

From an engineering perspective, construction of a gas pipeline is not complicated; however the associated infrastructure is complex. As an example, compressor stations have to be constructed about every 100KM along the pipeline and these are large engines which re-compress the gas to 100 atmospheres and send it down the pipeline. Gas pipelines use approximately 2-3% of the energy transported to keep the gas flowing. With economies of scale, it is more cost effective to run a 56 inch pipeline (TAPI proposed pipeline) than a 12 inch pipeline. The proposed pipeline path for the 12 inch line to Herat and the 56 inch line to India is shown in Figure 1 on page 2 of this report;

Figure 1: TAPI Pipeline Map

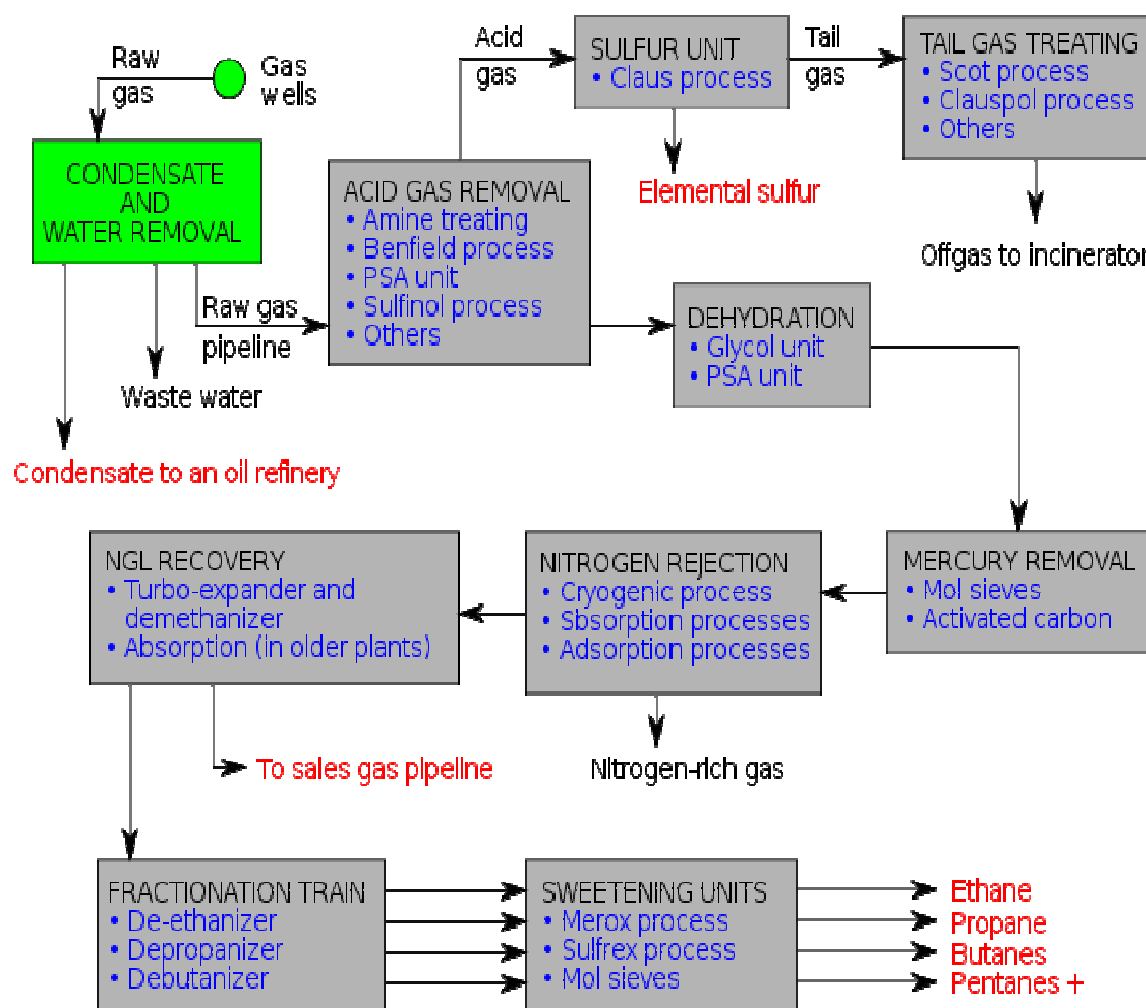


Source: Canadian Centre for Policy Alternatives

The natural gas from the Dauletabad field is very sour (up to 6% hydrogen sulfide), which will require complex treatment from a “Sweetening Plant.” The process is illustrated in Figure 2 on page 3 of this report. These processing plants are easily scalable; however, the larger the plant the better the economies of scale. The processes are complex and expensive to operate. Currently Petrofac is constructing a \$3.4 billion dollar facility, which can process (sweeten) up to 20 billion cubic meters (CM) of natural gas per year. This plant is scheduled to be completed in 2014.

Turkmenistan faces a limited export infrastructure to deliver the refined product to market. Considering these limitations, Turkmenistan’s potential to export its sweetened gas will be divided up as follows; 53% to Russia; 32% to China, 15% to Iran in 2015. A significant issue is whether or not Turkmenistan will sell a small amount of gas to Afghanistan, as they have agreed to sell large amounts of their future processed natural gas to both India and Pakistan. The TAPI pipeline agreement allows Afghanistan to take a percentage (8%) of the TAPI line supply as a “transmission fee,” which can be used to fuel limited thermal industries.

Figure 2: Natural Gas Sweetening Process;



Source: Wikipedia.org

3.0 Costs

A 12 inch gas line from Turkmenistan to Herat would need to supply 1.2 million cubic meters of sweetened natural gas per year to run a 200 megawatt power plant. The cost of the imported natural gas would amount to \$0.04-.06 per KWH and the cost to generate electricity would be an additional \$0.04-06 per KWH. The cost of this option to generate electricity is prohibitive compared to importing electricity directly from Turkmenistan. Turkmenistan has also declared its intention to increase electricity exports to Afghanistan. Earlier this year, Turkmenistan's President Gurbanguly Berdimuhamedow authorized construction of a new electric transmission line to quintuple current electricity export levels to 300 megawatts per year to Afghanistan.

The cost of constructing a 12 inch pipeline for 128 KM from the Dauletabad Gas Field to Herat is technically feasible. The internationally agreed \$7.6 billion dollar TAPI pipeline project is scheduled for construction within the next few years. Beginning a small project would require the same steps of engineering design, land procurement, agreements with the Turkmenistan government, sweetening plants, construction security, and all of the associated costs of running a pipeline. The costs are listed below and are based on average costs and are not specific to Afghanistan. The remainder of the report is a description of a natural gas

system to illustrate the complexity of running a natural gas utility and its associated infrastructure.

Table 1: Rough Order of Magnitude Costs

Pipeline - 128 KM	\$300-\$500K per KM	\$37-62 million dollars
Compressor stations	\$5 million per station	\$10 million dollars
Sweetening plant	1.2 million cubic meters/year	\$35-50 million dollars
Associated costs	training, equipment, SCADA	\$10 million

From a budgetary perspective it would require a minimum investment of \$92 million dollars to run the 12 inch line from the Dauletabad field to Herat. The cost of a 200 Megawatt natural gas plant would be in the vicinity of \$300 million dollars.

As a cost comparison, the construction of 220 KV electric line is on average \$150-\$250K per KM. The total cost of the 128 KM route would be approximately \$19-32 million. Looking at total capital costs, importing power is a much more attractive option than importing natural gas to fuel a 200 MW thermal power plant.

4.0 Overview of the Natural Gas Systems

4.1 Gas Pipelines

The biggest challenge, after initial gas field discovery, is transporting the gas from the field to the consumer. The natural gas chain follows the produced gas through its processing, transportation, and delivery to the consumers. At the gas processing plant, NGLs are separated for direct sale to the industrial and petrochemical markets. Methane is then transported by pipeline or LNG tanker to gas markets. Gas markets are generally residential and commercial users (utilizing gas for space heating), industry (directly burning natural gas), and electrical power generation.

Transporting natural gas from the wellhead to the final customer involves multiple processing steps and several physical plants. A natural gas pipeline system begins at the natural gas producing well or field. Once the gas leaves the producing well, a pipeline gathering system directs the flow either to a natural gas processing plant or directly to the mainline transmission grid, depending upon the initial quality of the wellhead product.

The processing plant produces pipeline-quality natural gas. This gas is then transported by pipeline to consumers or is put into underground storage for future use. Storage helps to maintain pipeline system operational integrity and/or to meet customer requirements during peak-usage periods.

Transporting natural gas from wellhead to market involves a series of processes and an array of physical facilities which include the following:

- **Gathering Lines** – These small-diameter pipelines move natural gas from the wellhead to the natural gas processing plant or to an interconnection with a larger mainline pipeline.

- **Processing Plant** – This operation extracts natural gas liquids and impurities from the natural gas stream.
- **Mainline Transmission Systems** – These large-diameter, long-distance pipelines transport natural gas from the producing area to market areas.
- **Underground Storage Facilities** – Natural gas is stored in depleted oil and gas reservoirs, aquifers, and salt caverns for future use.
- **Peak Shaving** – System design methodology permitting a natural gas pipeline to meet short-term surges in customer demands with minimal infrastructure. Peaks can be handled by using gas from storage or by line-packing with other compressed gases like propane.

4.2 The Transmission Grid and Compressor Stations

Pipelines are the most common, and usually the most economic, delivery system to transport gas from the field to the consumer. Pipelines are a fixed, long-term investment, which may not be economical for smaller and remote gas fields.

The volume of gas that can be transported in a pipeline depends on two main factors: the pipeline operating pressure and pipe diameter. The maximum diameter of pipelines continues to increase every few years. As diameters of 48 inch pipelines become common, the industry may be approaching the practical limit to onshore pipelines. To handle the increasing demand, it is likely that operating pressures will increase rather than the size of the pipe.

Most transmission pipelines operate at pressures of more than 60 atmospheres (atm), and some operate as high as 125 atm. To maintain a high operating pressure, compressors maintain the pressure of gas, and depending on the length of the pipeline and the topography, may be installed at intervals of 150 km to 200 km.

Increasing pressure requires larger and thicker pipes, larger compressors, and higher safety standards, all of which substantially increase the capital and operating expenses of a system. The gas industry uses an interesting unit to measure pipeline costs, dollars per inch per kilometer (\$/in.-km), measuring the cost of 1 inch diameter per kilometer length.

To address the potential for pipeline rupture, safety cutoff meters are installed along a mainline transmission system route. Devices located at strategic points are designed to detect a drop in pressure that would result from a downstream or upstream pipeline rupture and automatically stop the flow of natural gas beyond its location. Monitoring the pipeline as a whole are apparatus known as Systems Control and Data Acquisition (SCADA) systems. SCADA systems provide monitoring staff the ability to direct and control pipeline flows, maintaining pipeline integrity and pressures as natural gas is received and delivered along numerous points on the system, including flows into and out of storage facilities.

5.0 TAPI Pipeline

The Trans-Afghanistan Pipeline (TAP or TAPI) is a proposed natural gas pipeline being developed and funded by the Asian Development Bank. The pipeline will transport Caspian Sea natural gas from Turkmenistan through Afghanistan into Pakistan and then to India. The acronym, TAPI comes from the first letters of those countries. Proponents of the project see it as a modern continuation of the Silk Road. The Afghan government is expected to receive 8% of the project's revenue. This pipeline will require a large capital investment in both construction and Operations and Maintenance for an extended period of time.

5.1 Route

The 1,680 kilometers (1,040 mi) TAPI pipeline will run from the Dauletabad gas field through Afghanistan. The TAPI will be constructed alongside the highway running from Herat to Kandahar, and then via Quetta and Multan in Pakistan. The final destination of the pipeline will be the Indian town of Fazilka, near the border between Pakistan and India.

5.2 Technical features

The pipeline will be 1,420 millimeters (56 in) in diameter with a working pressure of 100 standard atmospheres (10,000 kPa). The initial capacity will be 27 billion cubic meters (bcm) of natural gas per year of which 2 bcm will be provided to Afghanistan and 12.5 bcm to each Pakistan and India. Later the capacity will increase to 33 bcm. Six compressor stations would be constructed along the pipeline. The pipeline is expected to be operational by 2014.

The estimated cost of the pipeline is US \$7.6 billion. The project is to be financed by the Asian Development Bank.

Turkmenistan-Afghan-Pakistan-India transnational gas pipeline, took a good step forward as Ashkabad and Islamabad completed and agreed upon the complex pricing formula. According to Petroleum Minister Dr. Asim Hussain, upon the conclusion of their negotiations, Pakistan and Turkmenistan announced that they signed the agreement in Ashkabad on November 15, 2011. This agreement is for the supplying of 1.3 bcfd of gas to Pakistan at 69 per cent of crude oil parity price.

Despite good news on the pricing formula, TAPI continues to be threatened by the increased intensity of the ongoing war and the deteriorating security situation in Afghanistan.

Afghanistan, Pakistan and India are the proposed main purchasers of the Turkmen gas which is to be supplied through the 1,640 kilometer pipeline at the estimated cost of \$ 7.6 billion. Pakistan and India, each are expected to receive 1.365 billion cubic feet daily (bcfd), while Afghanistan will receive 0.5 bcfd. All parties support the pipeline project and the Asian Development Bank (ADB) has agreed to provide funding.

The negotiations opened with Turkmenistan Deputy Minister for Energy Yarmuhammad Orazgulyev offering the gas at 74 per cent of crude parity price. But as calculated on the basis of transit cost needed to be paid to Afghanistan, Islamabad considered it to be too high.

At the end of the negotiations, Pakistan secured a final price of 69 per cent of the Brent crude parity at Afghanistan-Pakistan border, including the transit fee. Officials stated that depending on the security situation in Afghanistan, Pakistan is expected to start receiving Turkmen gas by December 2016. Officials also noted that India previously has bilaterally agreed on pricing with Turkmenistan.

Another good feature of the agreement is that Ashkabad has offered Islamabad to increase the gas supply from 1.3 to 2.0 bcfd if the two sides agree to transport 700 million cubic feet a day to the Pakistani southern port of Gwadar, located close to the Straits of Hormuz, for export as liquefied natural gas (LNG). With this agreement there appears to be excess natural gas available for Afghanistan's future needs if Pakistan is able to negotiate this agreement.

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